Center Independent Research & Development: JPL IRAD

Electrochemical Sensors for Understanding Icy Worlds

Completed Technology Project (2016 - 2018)

Project Introduction

As NASA explores Ocean Worlds and looks for habitable environments, it will be advantageous to perform liquid analyses of samples because (frozen) aqueous solutions will be the sample's natural state. As part of these missions, the ability to make bulk and trace soluble inorganic ion measurements will be critical to allow comparative oceanography of different worlds. Ion selective electrodes (ISEs) have demonstrated their value in making soluble ion measurements during the Phoenix lander mission on Mars. This project focuses on incorporating developments in ISE technology in the 10+ years since the Phoenix mission sensors were built in order to allow them to be more effective on upcoming longer duration Ocean Worlds missions.

As the exploration of Ocean Worlds in our Solar System advances a key science requirement will be to understand what observations at the surface tell us about the oceans hidden below. The ability to make bulk and trace soluble inorganic ion measurements will be critical to understand the habitability of these oceans by providing constraints on the redox balance, pH, and chemosynthetic metabolism pathways available in the oceans. Ion selective electrode (ISE) technology is a powerful tool for measuring soluble inorganic ions as demonstrated on the Mars Phoenix lander mission. Sensor technology has been improved in the 10+ years since the development of the Phoenix mission, primarily by the switch to solid contact ISEs (SC-ISEs) using nanostructured carbon materials (e.g., carbon nanotubes, platinum nanoparticles etc.). There are many benefits of SC-ISEs to planetary exploration including improved robustness over the long storage periods needed to travel to the outer solar system, the ability to be reduced in size without compromising sensor lifetime, improved limits-of-detection, and reduction in sensor-to-sensor variability. Our approach will be to incorporate the current state-of-the-art in laboratory SC-ISEs to accrue the benefits listed above, and then perform the necessary testing to bring the sensors to TRL 5.

Anticipated Benefits

This technology will enable the ability of future NASA in situ Ocean Worlds missions to measure soluble ions and constrain the physio-chemical conditions of the oceans to understand their habitability.

This technology will help the commercial space industry design better systems for monitoring water systems used during human spaceflight to and from the International Space Station as well as on potential longer duration flights.

Other Government Agencies including the EPA and NOAA will be able to use these rugged electrochemical sensor for waterway and ocean monitoring of trace and bulk soluble ions.

JPL_IRAD_Activities Project

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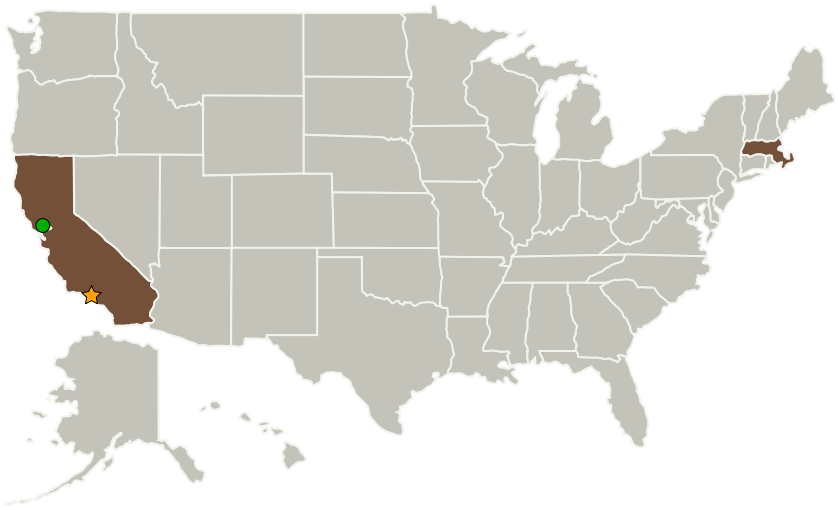
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California
●Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations	
California	Massachusetts

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Center Independent Research & Development: JPL IRAD

Project Management

Program Manager:

Fred Y Hadaegh

Project Manager:

Fred Y Hadaegh

Principal Investigator:

Aaron C Noell

Co-Investigator:

Anita M Fisher

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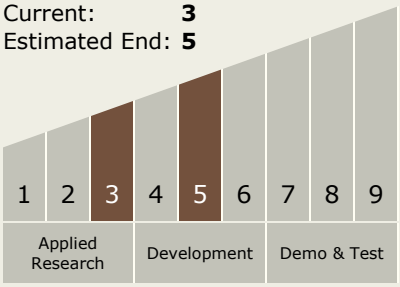
Images

JPL_IRAD_Activities Project Image
JPL_IRAD_Activities Project
(https://techport.nasa.gov/image/27869)

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **5**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.3 In-Situ Instruments and Sensors
    - TX08.3.6 Extreme Environments Related to Critical System Health Management

Target Destinations

Others Inside the Solar System, Foundational Knowledge

Supported Mission Type

Push